ESTABLISHING ROADSIDE SLOPES BY DIRECT SEEDING WITH LEGUMES AND WOODY ORNAMENTALS AND BY SEEDLINGS OF ORNAMENTAL PLANTS

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BY

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JHRP

JOINT HIGHWAY RESEARCH PROJECT
PURDUE UNIVERSITY AND
INDIANA STATE HIGHWAY COMMISSION

Interim Report

ESTABLISHING ROADSIDE SLOPES BY DIRECT SEEDING WITH LEGUMES, AND WOODY ORNAMENTALS AND BY SEEDLINGS OF ORNAMENTAL PLANTS

TO: J. F. McLaughlin, Director
Joint Highway Research Project

June 22, 1972

FROM: H. L. Michael, Associate Director
Joint Highway Research Project

Project: C-36-48C

File: 9-5-3

The attached Interim Report on Part II, "Selection, Establishment and Maintenance of Woody Ornamentals for Highway Plantings" of the HPR Research Study, "Research in Roadside Development and Maintenance" is presented for acceptance as partial fulfillment of the objectives of this Study. The Report is titled "Establishing Roadside Slopes by Direct Seeding with Legumes, and Woody Ornamentals and by Seedlings of Ornamental Plants" and has been authored by Messrs. D. F. Hamilton, R. E. McNiel and P. L. Carpenter.

The conclusions of this Report include recommendations for spacing of seedlings of desirable species for roadside plantings, species which were found less suited for roadside use and species not suited for roadside use under present knowledge and conditions. Recommendations as to direct seeding of several species are also included.

The Report will be forwarded for review, comment and acceptance of the ISHC and FHWA after acceptance by the JHRP Board.

Respectfully submitted,

Harold L Michael

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Table of Contents

Page

List of Tables

Introduction and Review of Literature 1

Experiment 1. Establishing Roadside Slopes with Ornamentals Planted as Seedlings 3

Materials and Methods 3

Results and Discussion 5

Experiment 2. Additional Evaluation of Ornamental Plants for use in Establishing Roadside Slopes when Planted as Seedlings. 17

Materials and Methods 17

Results and Discussion 17

Experiment 3. Establishing Roadside Slopes by Direct Seeding of Woody Ornamental Trees 20

Materials and Methods 20

Results and Discussion 21

Experiment 4. Establishing Roadside Slopes by Direct Seeding with Trefoil, Alfalfa, and Crownvetch. 22

Materials and Methods 22

Results and Discussion 22

Experiment 5. Additional Studies on the Establishment of Roadside Slopes by Direct Seeding with Legumes. 24

Materials and Methods 24

Results and Discussion 24

Conclusions 26

Review of Literature 28

List of Tables

Table		Page
1	Plants Studied for Possible Roadside Use and Size at Planting	4
2	Percentage of Woody Seedlings Surviving on Roadside Slopes when Spaced at Two Feet and Planted in May 1968.	7
3	Percentage of Woody Seedlings Surviving on Roadside Slopes when Spaced at Four Feet and Planted in May 1968	8
4	Height of Woody Seedlings in September 1971 when Planted on Roadside Slopes at Two-Feet Spacing in May 1968.	9
5	Height of Woody Seedlings in September 1971 when Planted on Roadside Slopes at Four-Feet Spacings in May 1968.	10
6	Percentage of *Yucca glauca* Surviving and Establishing on Highway Slopes when Planted at 12-, 15-, 18-, and 24-inch Spacings in May 1968.	12
7	Percentage of *Yucca filamentosa* Surviving and Establishing on Highway Slopes when Planted at 12-, 15-, 18-, and 24-inch Spacings on May 1968.	13
8	Percentage of *Yucca whipplei* Surviving and Establishing on Highway Slopes When Planted at 12-, 15-, 18-, and 24-inch Spacings in May 1968.	14
9	Height and width of *Yucca glauca* at 12-, 15-, 18-, and 24-inch Spacings along Roadside Slopes in May 1971.	15
10	Height and width of *Yucca filamentosa* at 12-, 15-, 18-, and 24-inch Spacings along Roadside Slopes in May 1971.	16
11	Plants Evaluated for Roadside Stabilization and Method of Planting.	18
12	Plant Survival and Establishment of Two Planting Dates on Highway Slopes.	19
13	Number of Tree Seedlings on Roadside Slopes on Roadside Slopes Following Direct Seeding in May 1970.	21
14	The Percent Cover Obtained on Roadside Slopes by Direct Seeding with Trefoil, Alfalfa, and Crownvetch.	23
15	Number of Plants and Percent Cover on Roadside Slopes following Direct Seeding with Legumes and Mulching with Bark or Straw.	25

For many situations grass may be the most practical roadside cover, for it combines good erosion control with attractive appearance and ease of establishment and maintenance. However, on roadside banks where grass survival is inadequate and mowing is impossible, deep-rooted legumes and woody ornamental plants that can maintain protective cover with little or no maintenance are very desirable. Also, as more naturalized roadsides are becoming preferred and as the nation seeks to preserve rural scenery, minimize erosion, and minimize the burden of mowing, legumes and ornamental plants are becoming more desirable.

Regardless of the plants used, a rapid and complete cover is very important. This is very difficult on the sterile and impoverished roadside slopes. Also, a low establishment and maintenance cost is very desirable. Direct seeding of legumes and ornamental plants seems to fit most of these requirements, but species need to be evaluated and rates of planting determined.

Whitaker (2) says that the most desirable season to mass propagate woody plant materials by direct seeding is in the fall. He further states that natural stratification takes place during the winter months, and the seed is ready for germination as the spring temperatures start to rise. Plant materials requiring only a few days of stratification or those requiring no treatment can be sown

in spring. Whitaker concludes by saying that it is desirable to hydroseed turf grasses, legumes, and woody plant material within the same operation if seeding can be done before October 15.

Many states use direct-seeded legumes often for roadside slopes. In upstate New York, birdsfoot trefoil has been widely employed (1). Pennsylvannia pioneered the use of crown vetch for road bank stabilization, and many old stands still serve admirably for this purpose (1). Many legumes are well-suited to roadside conditions because they are long-lived, drought resistant, and have attractive flowers. Legumes also have not been attacked by disease and insects along highway (1).

In other situations where direct seeding does not cover rapidly enough, seedlings may be useful. Establishment by seedlings is probably more expensive and time-consuming but have the advantage of having begun growth.

The objectives of these experiments were:

(1) To evaluate seedlings of ornamentals usable on roadside slopes.

(2) To evaluate legumes useful for establishment along roadside slopes by direct seeding and to determine rates of seeding.

(3) To evaluate woody plants useful for establishment along roadside slopes by direct seeding and to determine rates of seeding.

Experiment 1: Establishing Roadside Slopes with Ornamentals Planted as Seedlings

Materials and Methods

A field experiment to determine the feasibility of stabilizing roadside slopes with plants planted as seedlings was established in May 1968 along Interstate 74. The planting site was a slope with an eastern exposure and a three-year cover of grasses. The slope was cleared of natural vegetation by hand with no additional disturbance to the soil. Seedlings were then hand planted with a trowel or spade. The plants studied are listed in Table 1. Woody species were planted at 2-feet and at 4-feet spacings. Yucca sp. were planted at 12 inches, 15 inches, 18 inches, and 24 inches. Each species was planted in plots of 144 square feet and replicated 3 times at random positions on the slope.

No fertilization or watering program was maintained, although rainfall supplied ample moisture for seedling establishment. The average weekly rainfall for the period was: 1.98 inches in May, 0.82 inches in June, 0.88 inches in July, 1.38 inches in August, and 0.49 inches in September.

The planting site was mulched with bark to 4 inches immediately after planting seedlings. Dichlobenil (casoron) was incorporated in the bark mulch at 6.25 g/ft^3. Mulch was spread manually.

Table 1. Plants Studied for Possible Roadside Use and Size at Planting

Plant	Seedling Size
Yucca filamentosa	1-year
Yucca glauca	1-year
Yucca whipplei	1-year
Viburnum dentatum	6-18 inches
Ligustrum amurense (Amur Privet)	24 inches
Salix purpurea nana (Blue Artic Willow)	24 inches
Cercis canadensis (Eastern Redbud)	6-18 inches
Taxodium distichum (Bald Cypress)	4-12 inches

RESULTS AND DISCUSSION

Initial plant counts, September 1968, showed no differences in survival between two- and four-feet spacings of *Ligustrum amurense* and *Salix purpurea nana* (Tables 2 and 3). Both plants gave almost complete establishment over the three-year testing period. Even though establishment of *Salix* was good, growth and adaptability on the roadside slope was poor. Height of *Salix* at both spacings in September was virutally the same as the height of the seedlings planted in May 1968 (24 inches) (Tables 1, 4, and 5). On the other hand, seedlings of *Ligustrum* gave rapid establishment and cover at both spacings. At a two-feet spacing 72% of the plants were 40-65 inches tall (Table 4), while at a four-feet spacing 94% were from 40-65 inches (Table 5). Also, a much larger percentage of the plants spaced at four feet were 65 inches tall than of those at two feet.

Viburnum dentatum showed 50% more survival at a four-feet spacing through the first summer (Table 3). After the first summer, only slight decreases in plants established were recorded at both spacings (Tables 2 and 3). Although more plants spaced at four feet survived initially, growth rates were very similar between the two spacings. No plants were found to exceed 40 inches in height at either spacing (Tables 4 and 5), indicating only marginal adaptability to highway conditions.

Initial plant counts, September 1968, showed *Cercis canadensis* surviving much better at a four-feet spacing, even though this was only fair (Table 3). Survival at a two-feet spacing was extremely poor (Table 2). Unlike most of the other plants, overwintering of *Cercis* was poor at both spacings the first year (Tables 2 and 3). After the first winter complete establishment was found. Even though initial survival and overwintering of *Cercis* was not promising, growth and performance of established plants along the highway was good. At a two-feet spacing all of the plants were 40 inches tall or higher (Table 4). At four feet plants were found from 24 to 65 inches tall, but a large percentage was concentrated at 65 inches (Table 5).

Taxodium distichum survived poorly at both spacings (Tables 2 and 3). However, of those established the first summer only slight losses were found in later counts. *Taxodium* would provide complete cover on the highway, although it would not be rapid. Growth rates were quite similar at both spacings with over 50% of the established plants about 40 inches in height.

Of the three *Yucca* species studied, *Y. glauca* appeared to be the most suitable for highway conditions, although it is only marginally suited. Initial survival of *Y. glauca* was best at an 18-inch spacing, but after the first winter only very small differences existed between 15-, 18-, and 24-inch spacings (Table 6). After these losses during the first winter percent establishment was almost constant. In the final count the only significant difference in spacing appeared

Table 2. Percentage of Woody Seedlings Surviving on Roadside Slopes when Spaced at Two Feet and Planted in May 1968.

Plant	Percent Survival Date September 9, 1968	April 22, 1969	May 14, 1971	September 23, 1971
Viburnum denatum	40	38	36	36
Ligustrum amurense	86	84	83	83
Salix purpurea nana	99	99	99	99
Cercis canadensis	20	11	10	10
Taxodium distichum	29	23	22	21

Table 3. Percentage of Woody Seedlings Surviving on Roadside Slopes when Spaced at Four Feet and Planted in May 1968.

Plant	Percent Survival Date September 9, 1968	April 22, 1969	May 14, 1971	September 23, 1971
Viburnum dentatum	80	75	75	75
Ligustrum amurense	83	83	83	83
Salix purpurea nana	100	100	100	88
Cercis canadensis	64	42	42	42
Taxodium distichum	39	36	33	31

Table 4. Height of Woody Seedlings in September 1971 when Planted on Roadside Slopes at Two-Feet Spacings in May 1968.

Plant	Percentage of Plants at Each Height (inches)		
	24	40	65
Viburnum dentatum	35	65	--
Ligustrum amurense	28	48	24
Salix purpurea nana	100	--	--
Cercis canadensis	--	79	23
Taxodium distichum	25	55	20

Table 5. Height of Woody Seedlings in September 1971 when Planted on Roadside Slopes at Four-Feet Spacings in May 1968.

Plant	Percentage of Plants at Each Height (inches)		
	24	40	65
Viburnum dentatum	33	67	--
Ligustrum amurense	6	32	62
Salix purpurea nana	80	20	--
Cercis canadensis	20	46	34
Taxodium distichum	19	62	19

between 12 inches and 15 inches (Table 6). It is difficult to attribute this entirely to reduced plant competition for moisture and nutrients, but spacings of 15 inches and above do show considerably better establishment. No trends in growth rates due to spacing were apparent. Over 80% of the plants at all spacings were 16-30 inches in height and 10-24 inches in width (Table 9), indicating good cover on the slopes.

Y. filamentosa showed over 50% survival the first summer at all spacings (Table 7), but the plant was apparently unable to adapt and grow under highway stress as percent survival decreased constantly throughout the three-year test. Percent survival in May 1971 was less than 45% at all spacings. Growth of *Y. filamentosa* was also much poorer than that of *Y. glauca*. A large percentage at all spacings of the plants were less than 10 inches tall and 10 inches wide (Table 10), indicating only slight highway suitability.

Y. whipplei survived very poorly the first summer, and after the first winter 0% establishment was recorded for all spacings (Table 8).

Table 6. Percentage of *Yucca glauca* Surviving and Establishing on Highway Slopes when Planted at 12-, 15-, 18-, and 24-inch Spacings in May 1968.

	Percent Survival and Establishment		
Spacing	September 9, 1968	April 22, 1969	May 14, 1971
12 inches	45.4	40.9	39.6
15 inches	61.1	54.1	51.6
18 inches	73.8	57.6	57.1
24 inches	53.3	53.3	53.3

Table 7. Percentage of _Yucca_ _filamentosa_ Surviving and Establishing on Highway Slopes when Planted at 12-, 15-, 18-, and 24-inch Spacings in May 1968.

Spacing	Percent Survival and Establishment		
	September 9, 1968	April 22, 1969	May 14, 1971
12 inches	50.1	42.4	29.5
15 inches	52.7	44.4	44.4
18 inches	80.9	59.5	30.9
24 inches	60.0	60.0	36.6

Table 8. Percentage of _Yucca whipplei_ Surviving and Establishing on Highway Slopes When Planted at 12-, 15-, 18-, and 24-inch Spacings in May 1968.

Spacing	Percent Survival and Establishment September 9, 1968	 April 22, 1969
12 inches	6.8	0
15 inches	9.7	0
18 inches	28.5	0
24 inches	33.3	0

Table 9. Height and width of Yucca glauca at 12-, 15-, 18-, and 24-inch Spacings along Roadside Slopes in May 1971*

	Percentage of Plant at Each Height and Width (inches)		
Spacing (inches)	Ht(10-15) Wd(6-10)	Ht(16-24) Wd(11-15)	Ht(25-30) Wd(10-24)
12	12.2	38.7	48.9
15	20.0	53.3	26.6
18	12.0	60.0	28.0
24	6.2	13.2	62.5

* Planted May 1968

Table 10. Height and width of *Yucca filamentosa* at 12-, 15-, 18-, and 24-inch Spacings along Roadside Slopes in May 1971.*

Spacing (inches)	Percentage of Plants at Each Height and Width (inches) Ht(10-15) Wd(6-10)	Ht(16-24) Wd(11-15)	Ht(25-30) Wd(10-24)
12	25.6	48.7	25.6
15	18.1	45.4	36.3
18	30.7	15.3	53.8
24	45.4	9.1	45.4

* Planted May 1968

Experiment 2: Additional Evaluation of Ornamental Plants for Use in Establishing Roadside Slopes When Planted As Seedlings

A field experiment to evaluate plant materials for possible use in stablizing roadside slopes was established along the JCT of I-65 and Ind 43. The planting site was an east-facing slope with a pH ranging from 7.3 to 8.3. The slope site had been seeded with legumes in May 1970, and seedlings were planted by hand in this cover. Survival of two planting dates was compared, October 1970 and April 1971. Plants were planted at three-feet spacing in plots 300 square feet and replicated three times randomly on the slope.

No fertilization on watering program was maintained at either planting date.

The following plants were used: (Table 11)

Results and Discussion

Seedlings of Cornus, Sassafras, Taxodium, and Betula gave very poor survival both of the planting dates. An early-dry spring and the lack of nutrients probably hastened the death of these plants.

Nitrogen-fixing species appeared to withstand the high pH of the soil and give good survival. Of the nitrogen-fixing species planted both in fall and spring, Elaeangnus umbellata, Cercis, and Robinia gave good survival in both plantings, but survival from spring plantings was more than needed for complete cover. Other nitrogen-fixing species, Elaeangnus angustifolia, Alnus and Comptonia overwintered poorly when planted in fall, and gave marginal survival when planted in spring. Polygonum and Hemerocallis gave excellent survival and cover both planting dates.

Table 11. Plants Evaluated for Roadside Stabilization and Method of Planting.

Plant	Size at Planting
Cornus stolonifera	6-18 inches
Sassafrass albidium	6-18 inches
Elaeangnus umbellata	6-18 inches
Taxodium distichum	6-18 inches
Cercis canadensis	6-18 inches
Robinia pseudoacacia	6-18 inches
Elaeangnus angustifolia	6-18 inches
Alnus glutinosa	6-18 inches
Betula nigra	6-18 inches
Comptonia peregrina	2-year container plants
Hemerocallis sp.	2-to 4-inch root cuttings
Polygonum reynoutria	2-year container plants

Table 12. Plant Survival and Establishment of Two Planting Dates on Highway Slopes

Plant	Percentage Survival and Establishment in September 1971	
	October 1970	April 1971
Cornus stolonifera	4	9
Sassafras albidium	0	9
Taxidium distichum	4	-*
Elaeangnus umbellata	32	93
Elaeangnus angustifolia	0	16
Cercis canadensis	25	87
Alnus glutinosa	16	21
Comptonia peregrina	6	36
Robinia pseudoacacia	59	-
Betula nigra	3	-
Polygonum reynoutria	64	70
Hemerocallis sp.	100	-

* (-) indicates none planted at that time

Experiment 3: Establishing Roadside Slopes by Direct Seeding of Woody Ornamental Trees.

Materials and Methods

A field experiment to determine the feasibility of stabilizing roadside slopes by direct seeding of trees was established at the JCT of Ind 43 and I-65 in May 1970. The slope site had an eastern exposure, with no natural cover and a pH from 7.3 to 8.3. Each plant used was seeded in a plot of 300 square feet and randomly replicated three times. Legumes were put into these plots at the same time (Experiment 5). Seeding was done with a cyclone spreader and bark mulch was applied manually to one inch.

The following seeds and rates of seeding were used: _Taxodium distichum_ (bald cypress) at 0.14 lbs/100 sq ft (667 seeds), _Robinia fertilis_ (moss locust) at 0.01 lbs/100 sq ft (300 seeds), _Robinia pseudoacacia_ (black locust) at 0.04 lbs/100 sq ft (1000 seeds), _Cercis canadensis_ (eastern redbud) at 0.06 lbs/100 sq ft (1000 seeds), and _Rhus typhina_ (staghorn sumac) at 0.01 lbs/100 sq ft (267 seeds). Seeds had treatment according to the _Woody Plant Seed Manual_ (3). No fertilization or watering program was maintained during this experiment.

Taxodium distichum and _Rhus typhina_ gave very poor germination and need further study before direct seeding would be possible along highways.

Germination of _Robinia fertilis_ was excellent. The marked loss of seedlings from June 15 to September 21, 1971, is not abnormal, although slightly larger than would be expected. Lack of available moisture to the young seedlings were probably the main cause of decrease. However 23 seedlings/100 sq ft would provide adequate tree cover.

Results and Discussion

Table 13. Number of Tree Seedlings on Roadside Slopes Following Direct Seeding in May 1970.

	Seedlings/100 sq ft		
Plant	August 13 1970	June 15, 1971	September 21, 1971
Taxodium distichum	2	3	1
Robinia fertilis	186	137	23
Robinia pseudoacacia	26	154	75
Cercis canadensis	175	236	107
Rhus typhina	0.67	0.67	0.33

Experiment 4: Establishing Roadside Slopes by Direct Seeding with Trefoil, Alfalfa, and Crownvetch.

Materials and Methods

A field experiment to determine the feasibility of stabilizing roadside slopes by direct seeding was established along I-74 in May 1968. The planting site was a slope with a western exposure and a three-year cover of grasses. After being cleared of the natural vegetation, the area was overseeded with the various legumes. Each legume was seeded in a 400 square feet plot and replicated randomly three times on the slope. Half of each replication was covered by hand with corn-cob mulch to one inch and half the replication was left unmulched. Seed was spread by hand at the following rates, Dawn Birdsfoot trefoil at 10 lbs/acre, Viking trefoil at 10 lbs/acre, Travois alfalfa at 20 lbs/acre, and Penngift crownvetch at 20 lbs/acre. No fertilization or watering program was maintained during this experiment.

Results and Discussion

Travois alfalfa provided excellent cover when overseeded and covered with corn cob mulch; while cover without mulch was good but not as extensive as with the mulch, (Table 13).

A distinct difference was found between the two species of trefoil. Dawn gave about 50% cover when seeded and covered with mulch, while Viking gave virtually no cover when seeded and mulched (Table 13). Both gave extremely poor cover when seeded without mulch.

Penngift crownvetch gave fair cover when overseeded and mulched, but gave practically no cover when seeded without mulch (Table 13).

Table 14. The Percent Cover Obtained on Roadside Slopes by Direct Seeding with Trefoil, Alfalfa, and Crownvetch.

	Percent Cover*	
Plant	Corn cob Mulch	No. Mulch
Dawn Birdsfoot Trefoil	49.2	8.2
Viking Trefoil	4.5	0.3
Travois alfalfa	77.5	63.3
Penngift Crownvetch	36.6	1.2

[*] Percent cover was recorded October 1969, two growing seasons after seeding.

Experiment 5: Additional Studies on the Establishment of Roadside Slopes by Direct Seeding with Legumes.

Materials and Methods

A field experiment to determine the feasibility of stabilizing roadside slopes by direct seeding was established at the JCT of Ind 43 and I-65 in May 1970. The slope site had an eastern exposure with no natural cover and a pH from 7.3 to 8.3. Each legume was seeded in a plot of 300 square feet and randomly replicated three times. Seed was spread with a cyclone spreader at the following rates and covered manually with a one-inch bark mulch: Travois alfalfa at 10 lbs/acre, red clover at 6 lbs/acre, and Dawn trefoil at 6 lbs/acre. Teton alfalfa at 20 lbs/acre and Travois alfalfa at 20 lbs/acre were seeded similarly but mulched with straw to one-inch by a strawblower. No fertilization or watering program was maintained during this experiment.

Results and Discussion

Travois and Teton alfalfa at 20 lbs/acre with straw mulch provided rapid and almost complete cover on the roadside slope. Alfalfa at 10 lbs/acre, red clover and trefoil did not give sufficient slope stabilization in this experiment.

Table 15. Number of Plants and Percent Cover on Roadside Slopes following Direct Seeding with Legumes and Mulching with Bark or Straw.

Treatment	Percent Cover September 1971	Number of Plants (1 sq^2)
Travois alfalfa 10#/A (Bark Mulch)	5	4.0
Red Clover 6#/A (Bark Mulch)	1	1.6
Dawn Trefoil 6#/A (Bark Mulch)	1	2.0
Travois Alfalfa 20#/A (Straw Mulch)	90	10.0
Teton Alfalfa 20#/A (Straw Mulch)	85	9.0

Conclusions

Establishment by Seedlings

1. Spring planting of seedlings at spacings three feet or wider are recommended for roadside planting of the following species:

   Ligustrum amurense

   Cercis canadensis

   Elaeangnus umbellata

   Robinia pseudoacacia

   Polygonum regnoutria

   Hemerocallis sp.

   Yucca glauca

2. The following species were found to be less suited to roadside use but will give complete cover.

   Viburnum dentatum

   Taxodium distichum

   Elaeangnus angustifolia

   Yucca filamentosa

   Alnus glutinosa

3. The following species are not suited for roadside use without further study.

   Salix purpurea nana

   Cornus stolonifera

   Sassafras albidium

   Comptonia peregrina

   Betula nigra

   Yucca whipplei

Establishment by Direct Seeding

1. Travois and Teton alfalfa at 20 lbs/acre, and Dawn birdsfoot trefoil at 10 lbs/acre will provide excellent cover on roadsides when planted in the spring and mulched.
2. Direct seeding of *Robinia pseudoacacia* and *Cercis canadensis* will give adequate roadside cover. *Robinia fertilis* does not survive as well but gives adequate cover. *Taxodium distichum* and *Rhus typhina* do not successfully establish when direct seeded.

Review of Literature

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